**Maxwell's Equations**

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|  |  | This site aims to teach Maxwell's Equations in as simple and intuitive a manner as possible. This tutorial should be useful for anyone with an interest in electromagnetics. Don't fear the math - I'll explain that as well, while avoiding unnecessary rigor wherever possible. <http://www.maxwells-equations.com/>   |  |  |  | | --- | --- | --- | | [Introduction to Maxwell's Equations](http://www.maxwells-equations.com/index.php" \l "maxwells)  [Equation 1: Gauss' Law](http://www.maxwells-equations.com/gauss/law.php)  [Equation 2: Gauss' Magnetism Law](http://www.maxwells-equations.com/gauss/magnetism.php)  [Equation 3: Faraday's Law](http://www.maxwells-equations.com/faraday/faradays-law.php)  [Equation 4: Ampere's Law](http://www.maxwells-equations.com/ampere/amperes-law.php)  [Essay: Maxwell's Equations as a Whole](http://www.maxwells-equations.com/summary.php)  [Other Forms of Maxwell's Equations](http://www.maxwells-equations.com/forms.php)  Click on any term in Maxwell's Equations for Explanation===>  [Maxwell's Equations Forum](http://www.antenna-theory.com/phpbb2/index.php)  [External Links](http://www.maxwells-equations.com/links.php) | |  | | --- | | http://www.maxwells-equations.com/eq1-number1.gif[http://www.maxwells-equations.com/eq1-divergence.gif](http://www.maxwells-equations.com/divergence.php)[http://www.maxwells-equations.com/electric-flux-density.gif](http://www.maxwells-equations.com/density/electric-flux.php)[http://www.maxwells-equations.com/eq1-equals.gif](http://www.maxwells-equations.com/equals/eq1-equals.php)[http://www.maxwells-equations.com/electric-charge-density.gif](http://www.maxwells-equations.com/pho/charge-density.php)http://www.maxwells-equations.com/eq1-whitespace.gifhttp://www.maxwells-equations.com/eq2-number2.gif[http://www.maxwells-equations.com/eq2-divergence.gif](http://www.maxwells-equations.com/divergence.php)[http://www.maxwells-equations.com/magnetic-flux-density.gif](http://www.maxwells-equations.com/density/magnetic-flux.php)[http://www.maxwells-equations.com/eq2-equals.gif](http://www.maxwells-equations.com/equals/eq2-equals.php)[maxwell's equations says that there are no magnetic monopoles](http://www.maxwells-equations.com/zero.php)http://www.maxwells-equations.com/eq2-whitespace.gifhttp://www.maxwells-equations.com/eq3-number3.gif[http://www.maxwells-equations.com/eq3-curl.gif](http://www.maxwells-equations.com/curl/curl.php)[http://www.maxwells-equations.com/eq3-electric-field.gif](http://maxwells-equations.com/fields/electric.php)[http://www.maxwells-equations.com/eq3-equals.gif](http://www.maxwells-equations.com/equals/eq3-equals.php)[http://www.maxwells-equations.com/eq3-partial-B.gif](http://www.maxwells-equations.com/math/partial-magnetic-flux.php)http://www.maxwells-equations.com/eq3-whitespace.gifhttp://www.maxwells-equations.com/eq4-number4.gif[http://www.maxwells-equations.com/eq4-curl.gif](http://www.maxwells-equations.com/curl/curl.php)[http://www.maxwells-equations.com/eq4-magnetic-field.gif](http://www.maxwells-equations.com/fields/magnetic.php)[http://www.maxwells-equations.com/eq4-equals.gif](http://www.maxwells-equations.com/equals/eq4-equals.php)[http://www.maxwells-equations.com/eq4-partial-D.gif](http://www.maxwells-equations.com/math/partial-electric-flux.php)[http://www.maxwells-equations.com/eq4-plus.gif](http://www.maxwells-equations.com/math/plus.php)[electric current density](http://maxwells-equations.com/density/current.php) | |   **Related Equations** -- [Continuity Equation](http://maxwells-equations.com/equations/continuity.php) -- [The Wave Equation](http://maxwells-equations.com/equations/wave.php)  **Math** -- [The Curl](http://www.maxwells-equations.com/curl/curl.php) -- [Divergence](http://www.maxwells-equations.com/divergence.php) -- [Partial Derivative](http://www.maxwells-equations.com/math/partial-derivative.php) -- [Vector Fields](http://www.maxwells-equations.com/vector-functions.php)  **Field Sources** -- [Electric Charge Density [http://www.maxwells-equations.com/phoV.gif](http://www.maxwells-equations.com/pho/charge-density.php)](http://www.maxwells-equations.com/pho/charge-density.php) -- [Electric Current Density **J**](http://maxwells-equations.com/density/current.php)  **Physical Constants** -- [Permittivity [http://www.maxwells-equations.com/epsilon.gif](http://maxwells-equations.com/materials/permittivity.php)](http://maxwells-equations.com/materials/permittivity.php) -- [Permeability [http://www.maxwells-equations.com/mu.gif](http://www.maxwells-equations.com/materials/permeability.php)](http://www.maxwells-equations.com/materials/permeability.php) -- [Conductivity [http://www.maxwells-equations.com/sigma.gif](http://maxwells-equations.com/materials/conductivity.php)](http://maxwells-equations.com/materials/conductivity.php)  This website is intended to be a source of knowledge for learning about and understanding **Maxwell's Equations**.  This website will strive to make **Maxwell's Equations** understandable, without unnecessary complexity. |  |

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| The work on this website is copyrighted. No portion of this Maxwell's Equations website may be copied without permission from the author. Copyright 2012 Maxwell's Equations.com. [VSWR](http://www.antenna-theory.com/definitions/vswr.php).  **Introduction to Maxwell's Equations**  Maxwell's Equations are a set of 4 complicated equations that describe the world of electromagnetics. These equations describe how electric and magnetic fields propagate, interact, and how they are influenced by objects.  James Clerk Maxwell [1831-1879] was an Einstein/Newton-level genius who took a set of known experimental laws (Faraday's Law, Ampere's Law) and unified them into a symmetric coherent set of Equations known as Maxwell's Equations. Maxwell was one of the first to determine the speed of propagation of electromagnetic (EM) waves was the same as the speed of light - and hence to conclude that EM waves and visible light were really the same thing.  Maxwell's Equations are critical in understanding [Antennas](http://www.antenna-theory.com/) and Electromagnetics. They are formidable to look at - so complicated that most electrical engineers and physicists don't even really know what they mean. Shrouded in complex math (which is likely so "intellectual" people can feel superior in discussing them), true understanding of these equations is hard to come by.  This leads to the reason for this website - an intuitive tutorial of Maxwell's Equations. I will avoid if at all possible the mathematical difficulties that arise, and instead describe what the equations mean. And don't be afraid - the math is so complicated that those who do understand complex vector calculus still cannot apply Maxwell's Equations in anything but the simplest scenarios. For this reason, intuitive knowledge of Maxwell's Equations is far superior than mathematical manipulation-based knowledge. To understand the world, you must understand what equations mean, and not just know mathematical constructs. I believe the accepted methods of teaching electromagnetics and Maxwell's Equations do not produce understanding. And with that, let's say something about these equations.  Maxwell's Equations are laws - just like the law of gravity. These equations are rules the universe uses to govern the behavior of electric and magnetic fields. A flow of electric current will produce a magnetic field. If the current flow varies with time (as in any wave or periodic signal), the magnetic field will also give rise to an electric field. Maxwell's Equations shows that separated charge (positive and negative) gives rise to an electric field - and if this is varying in time as well will give rise to a propagating electric field, further giving rise to a propgating magnetic field.  To understand Maxwell's Equations at a more intuitive level than most Ph.Ds in Engineering or Physics, click through the links and definitions above. You'll find that the complicated math masks an inner elegance to these equations - and you'll learn how the universe operates the Electromagnetic Machine.  [maxwell's equations](http://www.maxwells-equations.com/index.php)  Here is a tutorial video explaining Maxwell's Equations intuitively:  [Top: Maxwell's Equations](http://www.maxwells-equations.com/) |